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Materiel Test Procedure 4-3-107
U. S. Army Armor and Engineer Board4066
U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

PROJECTILE, ARMOR-DEFEATING

1. OBJECTIVE

The objective of this Materiel Test Procedure (MTP) is to outline procedures for determining the degree that armor-defeating projectiles for direct fire, artillery class weapons meet the specifications of the Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), or other approved criteria.

2. BACKGROUND

The long-range ammunition development goal for direct fire artillery class weapons in combat vehicles has been two basic projectiles, i.e., a multipurpose armor-defeating antipersonnel/antimateriel projectile and a smoke projectile. To date this goal has only been realized to a limited extent in one multipurpose type projectile.

For the purpose of this MTP, ammunitions for direct fire artillery class weapons are grouped into two broad categories, i.e., armor-defeating and antipersonnel/antimateriel. The armor-defeating category can be further divided into three groups, i.e., kinetic energy projectiles, chemical energy projectiles, and high explosive plastic projectiles.

Kinetic energy armor-defeating projectiles produce the desired target effects because of their mass (hardness, density, and weight) and the velocity of travel at the time of impact with the target (striking velocity). The following types are included in the kinetic energy group: Armor Piercing (AP), Armor Piercing Discarding Sabot (APDS) and Armor Piercing Fin Stabilized Discarding Sabot (APFSDS).

Chemical energy (shaped charge) projectiles cause their damaging effect by focusing the gases released as the high explosive detonates into a high pressure jet stream. The shaped charge must be held away from the target a certain distance to allow the jet stream to form. This distance is called standoff. Upon impact with the target, the jet stream will displace the armor plate. This, in many cases, will have an explosive effect upon the target or cause fires. An important characteristic of chemical energy projectiles is that their target defeating potential is not affected by range. The following types are included in the chemical energy group: High Explosive Antitank (HEAT), and High Explosive Antitank-Multipurpose (HEAT-MP).

High Explosive Plastic (HEP) projectile has a steel body which contains the plastic explosive filler. It is primarily an antipersonnel/antimateriel round; however, it can also be used in the armor defeating role. HEP

will produce varying results, with concussion being the primary target effect. Depending on the type and thickness of the armor, spalling (chipping of the armor plate opposite the point of impact) may occur simultaneously with concussion. These effects will kill or injure the crew, damage fire control instruments and other interior components.

All of the above projectile types have a tracer element which is shown by a suffix "-T," for example, HEAT-MP-T.

To be effective, a projectile must be safe to handle and use under a variety of conditions, possess a maximum degree of accuracy and reliability, and be relatively simple to use.

In order to determine the extent to which its functional performance and military characteristics conform to requirements of the applicable QMR, SDR, or other appropriate criteria, each type projectile should be tested in the field by personnel representative of those who will actually use and maintain the item under combat conditions.

3. REQUIRED EQUIPMENT

- a. Appropriate Weapon System
- b. Firing Range(s)
- c. Standard Ammunition for comparative firing, when applicable
- d. Maintenance Facilities (organizational, direct support and general support)
- e. Appropriate Firing Tables
- f. Aiming Data Chart, when applicable
- g. Meteorological Equipment, as required for:
 - 1) Wind speed and direction
 - 2) Ambient temperature
 - 3) Relative humidity
- h. Appropriate Panel and Silhouette Targets
- i. Communication Equipment, as required
- j. Transport Vehicles for Ammunition, Equipment and Personnel
- k. Ambulance and Aidman
- l. Other Equipment and Facilities as required by the individual referenced Materiel Test Procedures
- m. Dummy Ammunition of appropriate types

4. REFERENCES

- A. Post (or test site) Range Regulation
- B. AR 385-63, Safety Regulations for Firing Ammunition for Training, Target Practice and Combat.
- C. AR 700-1300-8, Malfunctions Involving Ammunition and Explosives.

- D. FM 17-12, Tank Gunnery.
- E. TM 9-1300-206, Care, Handling, Preservation and Destruction of Ammunition.
- F. MTP 3-3-500, Preoperational Inspection and Physical Characteristics (Armament and Individual Weapons).
- G. MTP 2-3-500, Preoperational Inspection and Physical Characteristics.
- H. USATECOM REG 385-6, Verification of Safety of Materiel During Testing.
- I. MTP 4-3-501, Personnel Training.
- J. MTP 10-3-501, Operator Training and Familiarization.
- K. MTP 4-3-514, Safety Hazards.
- L. MTP 4-3-500, Preoperational Inspection and Physical Characteristics.
- M. MTP 4-3-515, Human Factors Engineering
- N. MTP 4-3-519, Compatibility with Fire Control Equipment.
- O. MTP 4-3-517, Combat Vehicle Ammunition Stowage and Transportability.
- P. MTP 3-3-505, Speed and Precision of Lay.
- Q. MTP 3-3-503, Boresight and Zero.
- R. MTP 4-3-522, Combat Vehicle Ammunition Functioning.
- S. MTP 3-3-510, Weapons Functioning.
- T. MTP 3-3-516, Obscuration.
- U. MTP 3-3-512, Round-to-Round Dispersion.
- V. MTP 3-3-513, First and Subsequent Round Hitting.
- W. MTP 3-3-507, Tracking and Hitting Performance, Stationary Gun Mount-Moving Target.
- X. MTP 3-3-508, Tracking and Hitting Performance, Moving Gun Mount-Stationary Target.
- Y. MTP 3-3-509, Tracking and Hitting Performance, Moving Gun Mount-Moving Target.
- Z. MTP 4-3-504, User Reaction.
- AA. MTP 4-3-513, Maintenance.
- AB. MTP 4-3-502, Ammunition Functioning and Reliability.

5. SCOPE

5.1 SUMMARY

This MTP describes procedures to be used in evaluating armor-defeating artillery class ammunition for use in direct fire weapons as follows:

a. Preparation for Test. Arrange for required facilities and review the safety release to determine the operational limitations, if any, placed on the test item due to safety hazards.

b. Personnel training. Procedures for conducting the necessary pretest training and familiarizing personnel with documents covering the handling and firing of ammunitions and recording related data.

c. Safety Hazards. A determination of the inherent safety hazards and a continuous evaluation of safety aspects of the test item throughout the service test to support the safety confirmation (safe for intended use) statement required in service test reports.

d. Preoperational Inspection and Physical Characteristics. Pre-test inspection and service of the test items as required to ensure that they are in proper condition and to determine whether physical characteristics meet specified requirements.

e. Human Factors Engineering. An evaluation to determine the human factors engineering aspects of the test ammunition and its compatibility with the skills and aptitudes of personnel who will use and service it.

f. Compatibility with Fire Control Equipment. A test to determine the compatibility of the test ammunition with the sights and other fire control equipment with which it will be used.

g. Combat Vehicle Ammunition Stowage and Transportability. A test to determine the adequacy of stowage facilities for the test ammunition and whether the stowing and transporting for varying distances has any adverse effect on its performance.

h. Speed and Precision of Lay. A test to determine the average time to lay the sights precisely on a target under optimum and field conditions.

i. Boresight and Zero. A test to determine:

- 1) Whether the test weapon and associated fire control equipment can be aligned on a common aiming point at prescribed ranges.
- 2) Whether there is sufficient movement of the sights or mount to permit zeroing the system.
- 3) The degree to which boresight alignment can be maintained under varying climatic and operating conditions.

j. Ammunition Functioning. An evaluation of all aspects of ammunition functioning except terminal effectiveness (kill capability).

k. Weapon Functioning. An evaluation of all aspects of weapon functioning when firing the test ammunition throughout various stages of usable gun barrel life.

l. Obscuration. An evaluation to determine the degree and time that muzzle flash, smoke, blast, and dust cause the target to be obscured from the gunner's/commander's view.

m. Round-to-Round Dispersion. A test to determine the dispersion characteristics and hitting probability of the test ammunition-weapon-fire control combination against vertical targets.

n. First and Subsequent Round Hitting. A test to determine the first and subsequent round hitting capability of the test ammunition-weapon-fire control combination against vertical targets at unknown ranges.

o. Tracking and Hitting Performance, Stationary Gun Mount-Moving Target. A test to determine the effectiveness of the test ammunition-weapon-fire control combination under these conditions.

p. Tracking and Hitting Performance, Moving Gun Mount-Stationary Target. A test to determine the effectiveness of the test ammunition-weapon-fire control combination under these conditions.

q. Tracking and Hitting Performance, Moving Gun Mount-Moving Target. A test to determine the effectiveness of the test ammunition-weapon-fire control combination under these conditions.

r. User Reaction. A determination of the reaction of service personnel to the use of the test ammunition.

s. Maintenance Evaluation. A study to determine the maintainability of the test ammunition and evaluation of its maintenance test package.

t. Ammunition Functioning Reliability. A study to evaluate the reliability of the test ammunition.

5.2 LIMITATIONS

Both the HEP and HEAT-MP have antipersonnel/antimateriel capabilities; however, only their armor-defeating role is covered in this MTP.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Ensure the availability of personnel with the proper Military Occupational Specialty (MOS) for the weapon system(s) to be used in testing the test items.

b. Ensure that key personnel are familiar with the pertinent portions of references 4A through 4E.

6.1.2 Equipment and Facilities

Ensure that equipment and facilities listed in paragraph 3 and in Materiel Test Procedures referenced in paragraph 4 above are available.

6.1.3 Weapon System

Ensure that the weapon and fire control systems to be used in conjunction with the test have been inspected, serviced, adjusted, and repaired, if required, in accordance with procedures described in MTP 3-3-500 (ref 4F) and MTP 2-3-500 (ref 4G).

NOTE: Gun barrels should have at least 75 percent of expected life remaining at the beginning of test firing.

6.1.4 Safety Release

The project officer shall ensure that a safety release (ref 4H) which includes information pertaining to specific safety hazards peculiar to the test item and/or operational limitations of the weapon system, has been received from HQ USATECOM, is understood, and complied with during testing.

6.1.5 Stowage

The fighting compartment of the parent vehicle should be stowed to the extent practicable with prescribed on-equipment materiel and basic issue items in order to create a realistic situation for handling the test items and performing required firing tasks.

6.2 TEST CONDUCT

NOTE: Figure 1 depicts the applicable firing tests by ammunition type.

6.2.1 Personnel Training

Conduct tests and record data as described in MTP 4-3-501 (ref 4I) and MTP 10-3-501 (ref 4J) for the test ammunition and weapon system respectively.

6.2.2 Safety Hazards

Conduct a continuing evaluation of all safety aspects of the test items as described in MTP 4-3-514 (ref 4K).

6.2.3 Preoperational Inspection and Physical Characteristics

Perform inspections, checks, inventories, measurements, and weighing as described in MTP 4-3-500 (ref 4L).

6.2.4 Human Factors Engineering

Determine the effectiveness of the man-machine relationship during use of the test items as described in MTP 4-3-515 (ref 4M).

Firing Tests	Ammunition Type*					
	1	2	3	4	5	6
Boresight and Zero	X	X	X	X	X	X
Ammunition Functioning	X	X	X	X	X	X
Weapon Functioning	X	X	X	X	X	X
Obscuration	X	X	X	X	X	X
Round-to-Round Dispersion	X	X	X	X	X	X
First and Subsequent Round Hitting	X	X	X	X	X	X
Tracking & Hitting Perf, Stationary Gun Mount-Moving Target	X	X	X	X	X	X
Tracking & Hitting Perf, Moving Gun Mount-Stationary Target	X	X	X	X	X	X
Tracking & Hitting Perf, Moving Gun Mount-Moving Target	X	X	X	X	X	X

- *1. AP
- 2. APDS
- 3. APFSDS
- 4. HEP
- 5. HEAT
- 6. HEAT-MP

- NOTE: 1. Training practice (TP) rounds will be subjected to the same tests as their combat counterpart.
2. The round used for zeroing will be the primary armor defeating round unless otherwise specified.

Figure 1. Tests for Armor-Defeating Main Armament Rounds.

6.2.5 Compatibility with Fire Control Equipment

Conduct pertinent tests as described in MTP 4-3-519 (ref 4N).

NOTE: If firing table data is not available or a reticle for the test ammunition is not provided in the fire control system, an aiming data chart will have to be prepared in conjunction with firing tests. See paragraph 45 and Figure 34 of reference 4D for detailed information.

6.2.6 Ammunition Stowage and Transportability

Conduct tests as described in MTP 4-3-517 (ref 4O).

6.2.7 Speed and Precision of Lay

Conduct tests as described in MTP 3-3-505 (ref 4P).

6.2.8 Boresight and Zero

Boresight and zero the main armament weapon system using the primary armor defeating round, unless otherwise directed, and conduct other pertinent tests as described in MTP 3-3-503 (ref 4Q).

6.2.9 Ammunition Functioning

Conduct tests as described in MTP 4-3-522 (ref 4R).

6.2.10 Weapons Functioning

Conduct tests as described in MTP 3-3-510 (ref 4S).

6.2.11 Obscuration

Make observations and conduct tests, when required, as described in MTP 3-3-516 (ref 4T).

6.2.12 Round-to-Round Dispersion

Conduct tests as described in MTP 3-3-512 (ref 4U).

6.2.13 First and Subsequent Round Hitting

Conduct tests as described in MTP 3-3-513 (ref 4V).

6.2.14 Tracking and Hitting Performance, Stationary Gun Mount-Moving Target

Conduct tests as described in MTP 3-3-507 (ref 4W).

6.2.15 Tracking and Hitting Performance, Moving Gun Mount-Stationary Target

Conduct tests as described in MTP 3-3-508 (ref 4X).

6.2.16 Tracking and Hitting Performance, Moving Gun Mount-Moving Target

Conduct tests as described in MTP 3-3-509 (ref 4Y).

6.2.17 User Reaction

Conduct evaluations as described in MTP 4-3-504 (ref 4Z).

6.2.18 Maintenance Evaluation

During the period of testing determine the maintenance characteristics of the test item as described in applicable sections of MTP 4-3-513 (ref 4AA) or other appropriate documents.

6.2.19 Ammunition Functioning Reliability

During the conduct of all firing tests determine the ammunition functioning reliability of the test ammunition and standard ammunition used for comparison purposes, when applicable, as described in the appropriate sections of MTP 4-3-502 (ref 4AB) or other appropriate documents.

6.3 TEST DATA

6.3.1 Personnel

Record applicable data for test personnel as described in MTP 4-3-501 (ref 4I) and/or MTP 10-3-501 (ref 4J).

6.3.2 Safety Hazards

Record data as described in MTP 4-3-514 (ref 4K).

6.3.3 Preoperational Inspection and Physical Characteristics

Record data as described in MTP 4-3-500 (ref 4L). When services, adjustments and repairs are made, they will be recorded here and also under the Maintenance Evaluation subtest.

6.3.4 Human Factors Engineering

Record data as described in MTP 4-3-515 (ref 4M).

6.3.5 Compatibility with Fire Control Equipment

Record data as described in MTP 4-3-519 (ref 4N).

- 6.3.6 Ammunition Stowage and Transportability
Record data as described in MTP 4-3-517 (ref 4O).
- 6.3.7 Speed and Precision of Lay
Record data as described in MTP 3-3-505 (ref 4P).
- 6.3.8 Boresight and Zero
Record data as described in MTP 3-3-503 (ref 4Q).
- 6.3.9 Ammunition Functioning
Record data as described in MTP 4-3-522 (ref 4R).
- 6.3.10 Weapons Functioning
Record data as described in MTP 3-3-510 (ref 4S).
- 6.3.11 Obscuration
Record data as described in MTP 3-3-516 (ref 4T).
- 6.3.12 Round-to-Round Dispersion
Record data as described in MTP 3-3-512 (ref 4U).
- 6.3.13 First and Subsequent Round Hitting
Record data as described in MTP 3-3-513 (ref 4V).
- 6.3.14 Tracking and Hitting Performance, Stationary Gun Mount-Moving Target
Record data as described in MTP 3-3-507 (ref 4W).
- 6.3.15 Tracking and Hitting Performance, Moving Gun Mount-Stationary Target
Record data as described in MTP 3-3-508 (ref 4X).
- 6.3.16 Tracking and Hitting Performance, Moving Gun Mount-Moving Target
- 6.3.17 User Reaction
Record data as described in MTP 4-3-504 (ref 4Z).
- 6.3.18 Maintenance Evaluation

Record data as described in applicable sections of MTP 4-3-513 (ref 4AA) or other appropriate documents.

6.3.19 Ammunition Functioning Reliability

Record data as described in applicable section of MTP 4-3-502 (ref 4AB) or other appropriate documents.

6.4 DATA REDUCTION AND PRESENTATION

a. Data obtained from all subtests covered by applicable referenced Materiel Test Procedures shall be summarized and evaluated according to procedures described in those Materiel Test Procedures. Appropriate charts, graphs, and tabulated summaries shall be used to present the data in a clear manner. Special consideration shall be given to any condition or circumstance contribution to any test result.

b. Calculations shall be performed as specified by the referenced individual Materiel Test Procedures, wherever applicable. All photographs shall be retained and suitably identified along with other illustrative material.

c. Chart all round-to-round dispersion and target hitting capabilities and compare these data obtained with:

- 1) Test items not transported
- 2) Test items transported for varying distances in the on-vehicle ammunition stowage racks
- 3) Standard ammunition fired for comparison purposes or other weapon systems, when applicable

d. Analyze all of the above data and present it in a manner so as to indicate whether the test ammunition meets the established criteria.

6.4.1 Safety Confirmation

A safety confirmation shall be presented in accordance with USATECOM Regulation 385-6.

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Kinetic energy projectiles

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